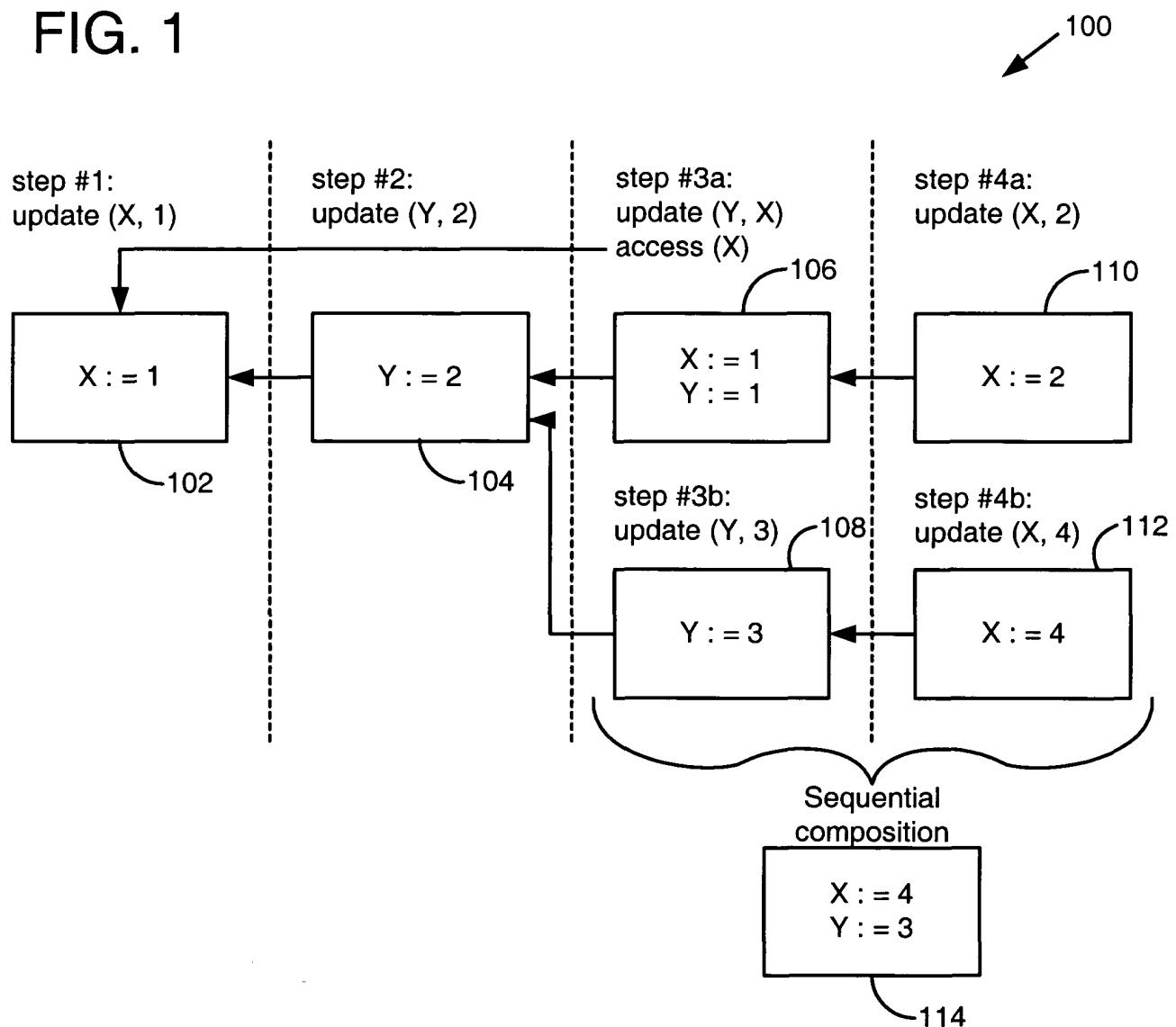# FIG. 1

FIG. 2

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FIG. 3

MODEL

IMPLEMENTATION

action

action

$X = \sqrt{4}$

$X = \sqrt{4}$

$X = \sqrt{4}$

$X = -2$

$X = 2$

$X = 2$
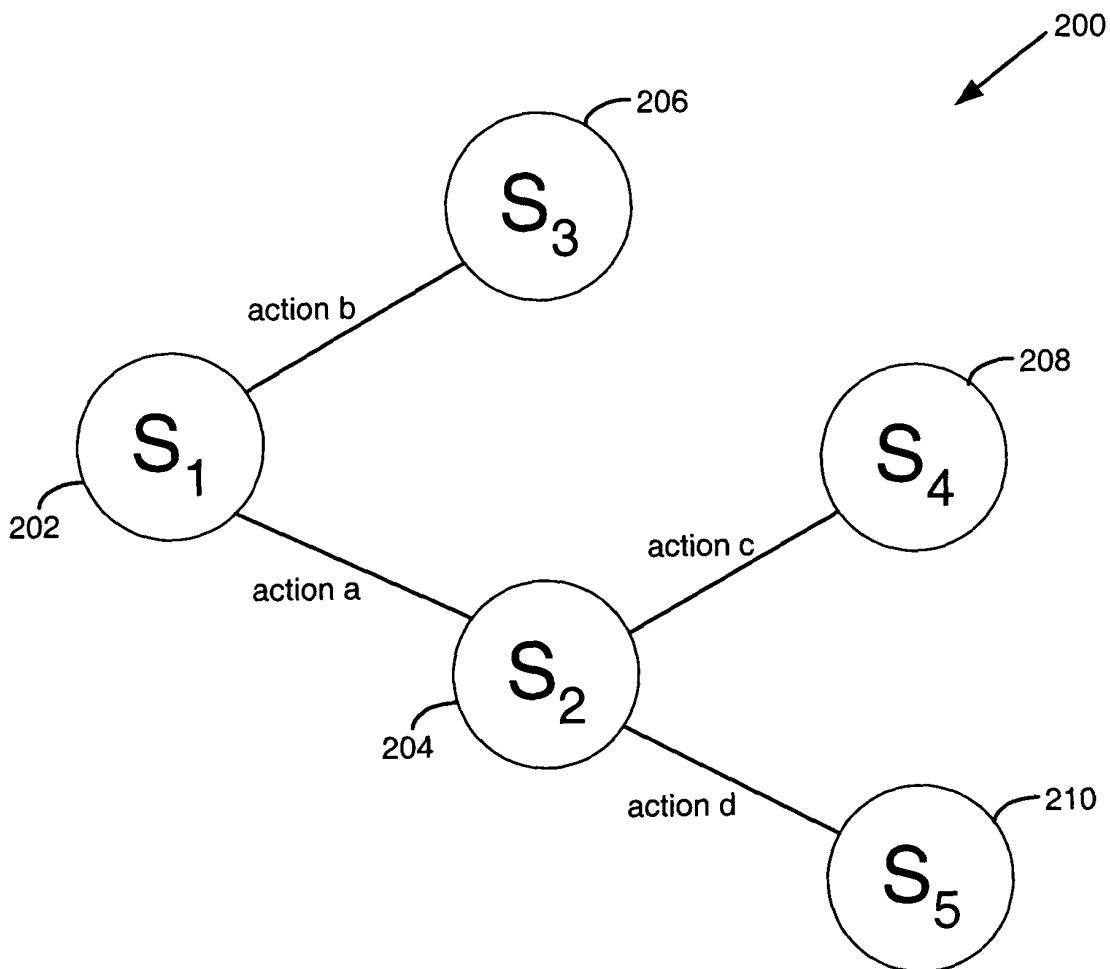
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FIG. 4

404

X = 2
Y = 6
Z = 4

402

X = 2
Y = 3
Z = 4

410

408

X = 6
Y = 6
Z = 4

X = 6
Y = 3
Z = 4

412

406

t_0 t_1 t_2

FIG. 5

500

504

Y = 6

502

X = 2
Y = 3
Z = 4

506

X = 6

508

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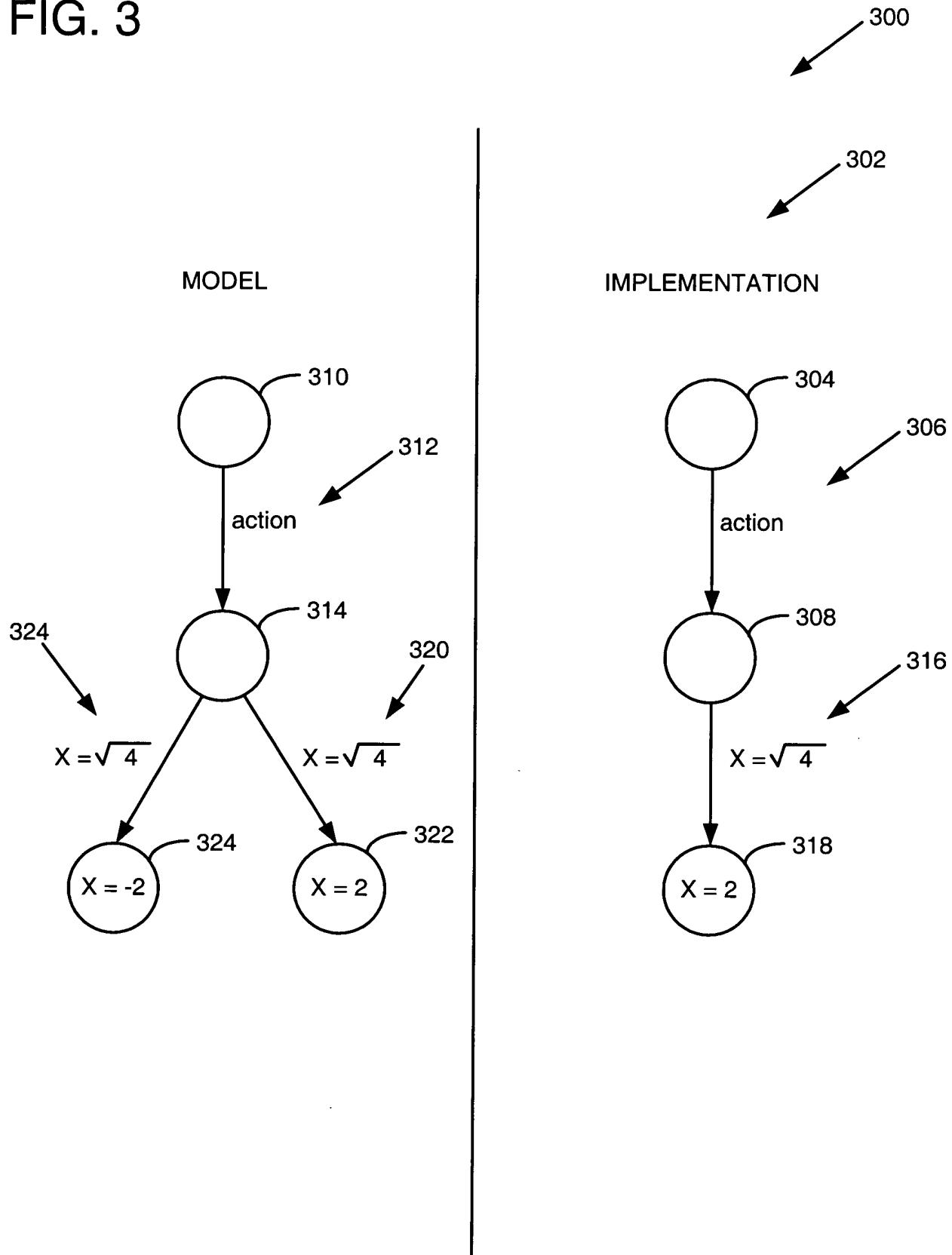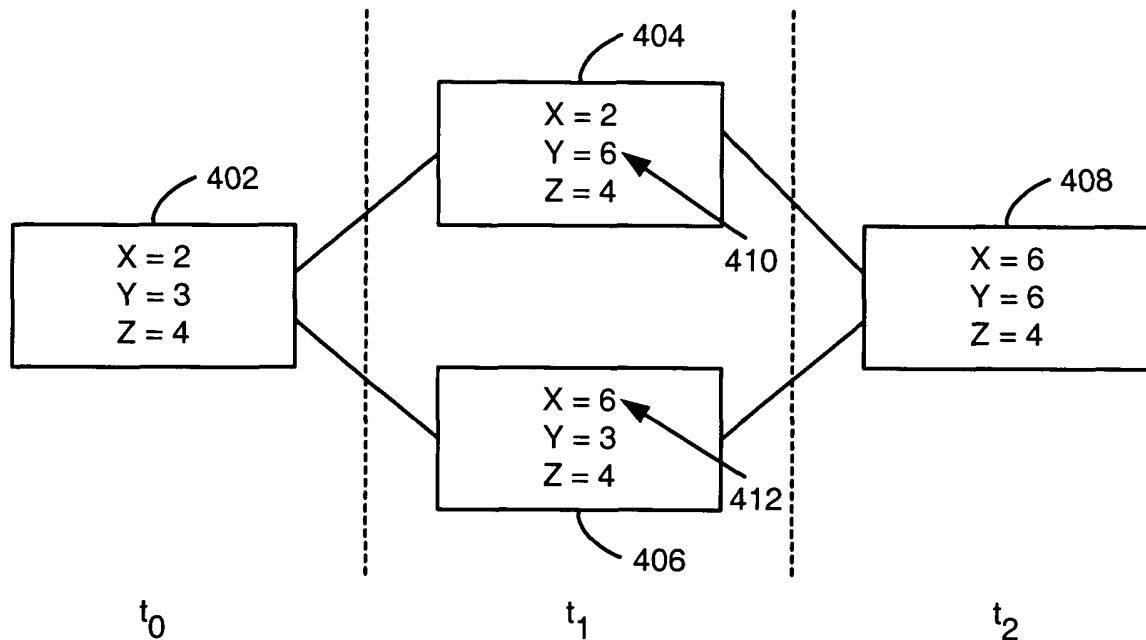
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FIG. 6

600

602

608

$X = 4, t_1$

$Y = 7, t_3$

604

606

612

$X = 4, t_1$

$X = 7, t_2$

618

616

$X = 7, t_2$

$Z = 8, t_2$

614

610

FIG. 7

700

TIME

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FIG. 8

800

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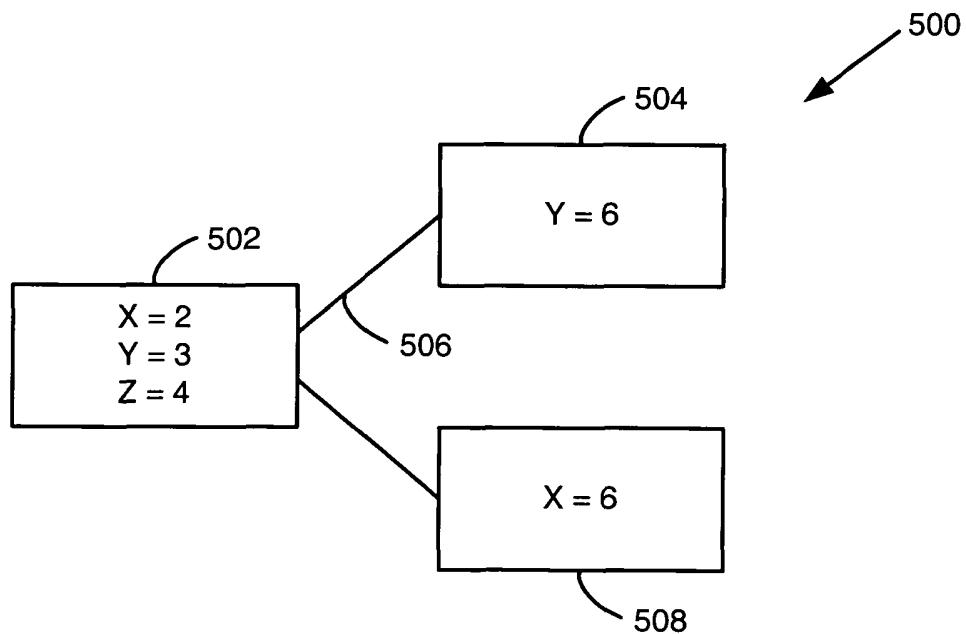
FIG. 9

FIG. 10
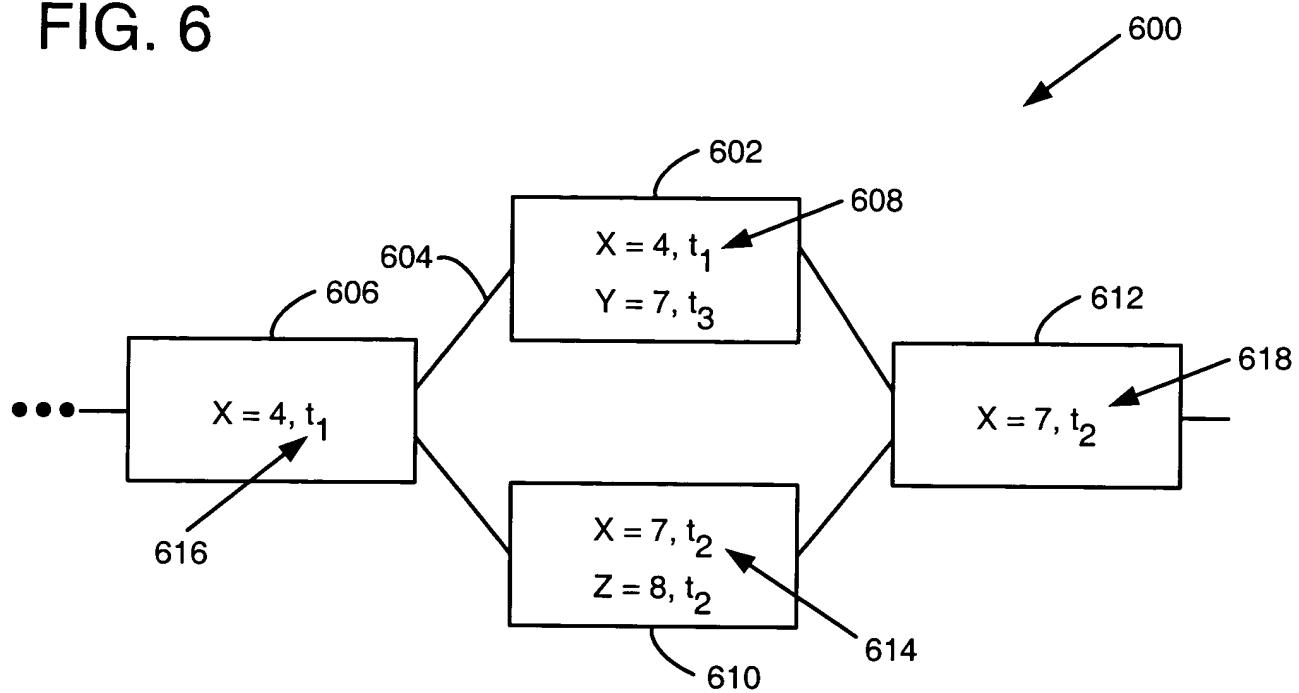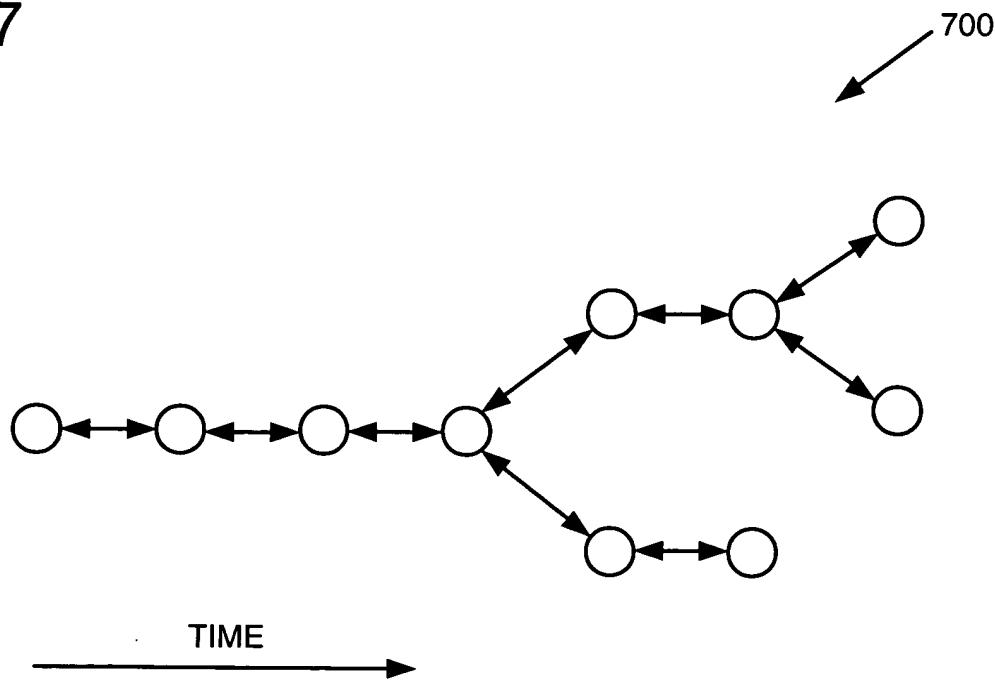
1000

```
class state
        Join ( )          1002
                let joinedOrigin = currentState.origin
                let b1 = currentState.bindings
  1006          let b2 = me.bindings

                currentState.bindings :=
  1004             { ] ->b1(1)  | ]  in Indices(b1) - Indices(b2) } +
                   { ] ->b2(1)  | ]  in Indices(b2) - Indices(b1) } +
  1008           { ] ->Resolve(joinedOrigin, v1, t2, v2, t2)
                      | ] in Indices(b1) * Indices(b2),
                          (v1, t1)=b1(1), (v2, t2)=b2(1) }


           Resolve (joinedOrigin as Timestamp,
  1010             v1 as value, t1 as Timestamp, v2 as Value, t2 as
                   Timestamp) as (Value, Timestamp)
                if Comparable (t1, t2) then
                   if Less (t1, t2) then
                        return (v2, joinedOrigin)
                   else                              1012
                        return (v1, joinedOrigin)
                else
  1014              return (Compose (v1, v2), joinedOrigin)
           Compose (v1 as value, v2 as value) as Value
                // dependent on the value domain


           Update (location as location, value as value)
  1016        currentState.bindings(location) := (value, currentState.origin)
  1018   Read (location as location) as Value
                return any v | ]  -> (v, _) in currentState.bindings where ]  = location
                if  none error "location" + location + "has not been initialized"
```

FIG. 11

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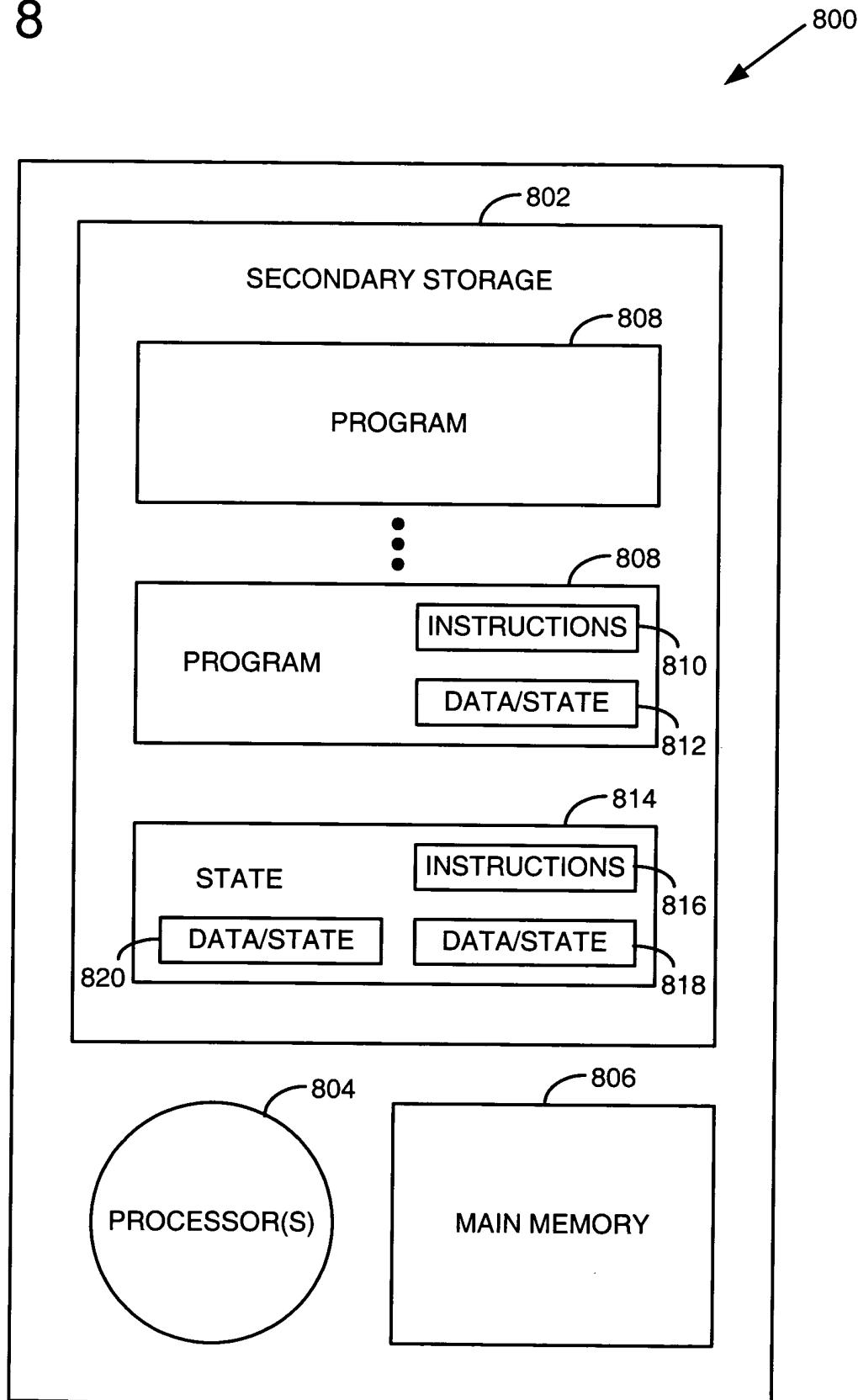
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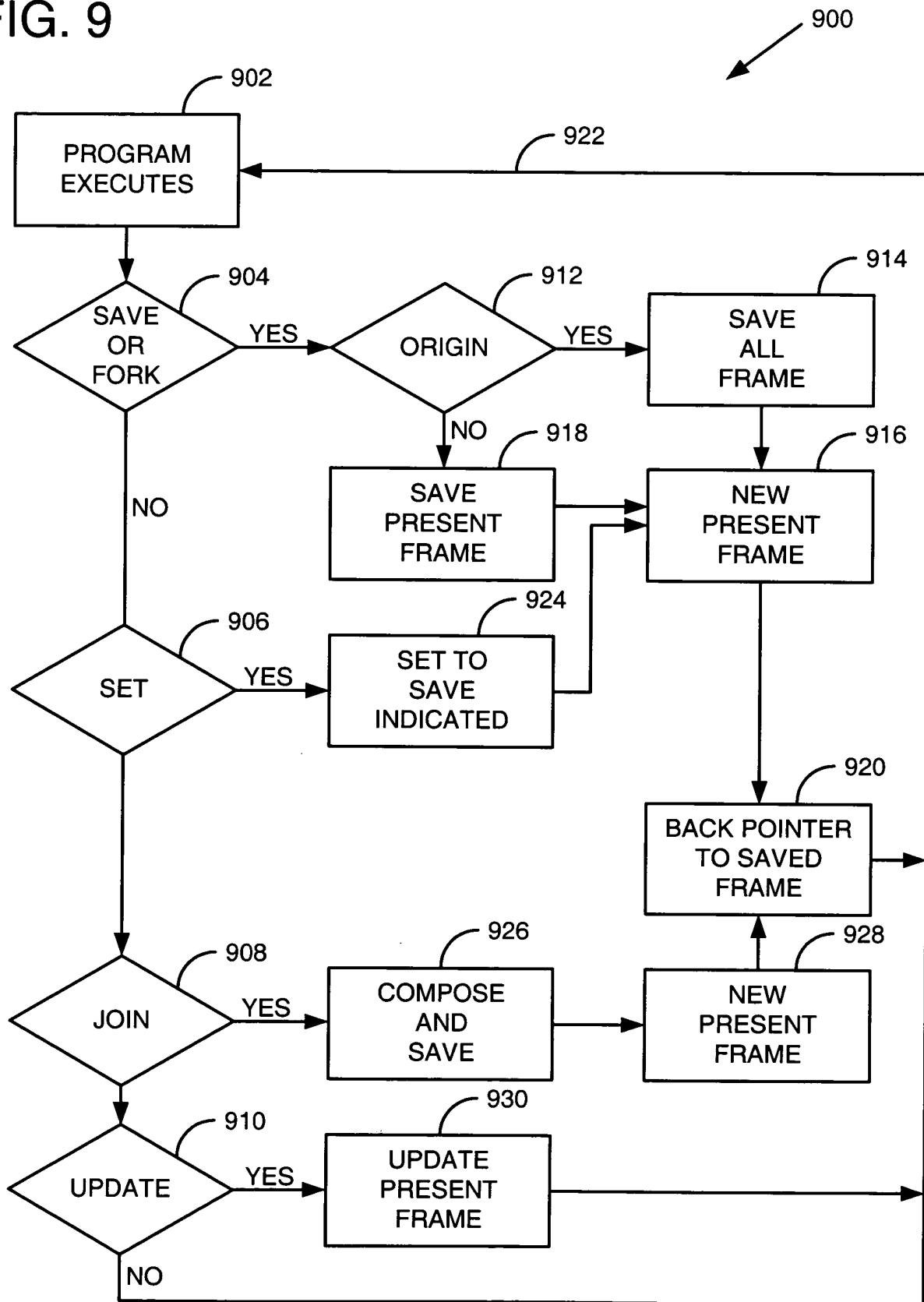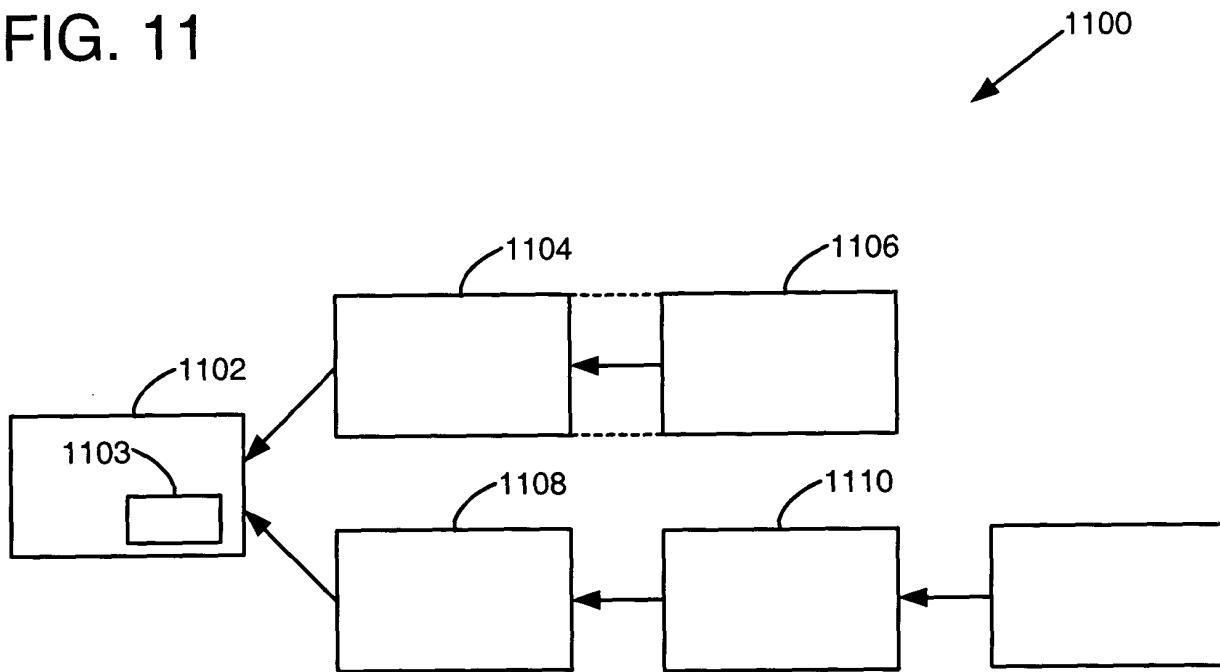# FIG. 12